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(12) **EUROPEAN PATENT APPLICATION**

(72) Inventor: **Crane, Randy T.
Fort Collins, CO 80525 (US)**

(74) Representative: **Colgan, Stephen James et al
CARPMAELS & RANSFORD
43 Bloomsbury Square
London WC1A 2RA (GB)**

(54) **Adaptive mode-switching method for scanning color and grayscale data**

(57) A circuit or method for use with or within an image capture device, such as a scanner, that calculates the color content of the image, as the color content varies throughout the image. For areas of the image where the color content is below a programmable threshold, the circuit or method automatically switches to grayscale mode during image capture. For areas of the image where the color content is above the programmable threshold, the circuit or method automatically switches back to color mode during image capture. For areas of the image containing text or line drawing data, the circuit or method automatically switches to 1-bit-per-pixel line drawing mode during image capture.
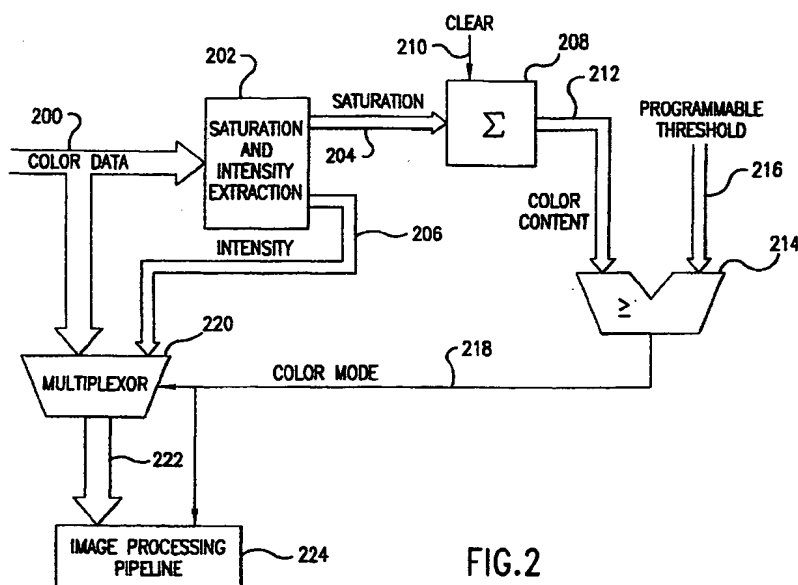
FIG.2

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Description

FIELD OF THE INVENTION

[0001] This invention relates generally to the field of electronic image capture and more particularly to the selective capture and processing of color, grayscale, and line drawing image data within a single image.

BACKGROUND OF THE INVENTION

[0002] In the field of electronic image capture, such as by a scanner, there are several modes of operation. For example, a scanner may capture images in full color mode or in a gray scale mode. When an image is captured in full color, the data may be much larger than the data generated by capturing the same image in a gray scale mode. Larger data files require more time for processing and transferring the image data. In some applications the larger data files will also require more memory in the image processing device and this inherently limits the size of image that may be processed. If a gray scale capture is used where possible, the resulting data file may be about one third the size of a corresponding full color image capture data file. Since the resulting data file may be one third the size of the color data file, it may be possible to process and transfer much larger images in a given transfer time, within the memory limitations of the device.

[0003] Many current image capture devices allow the user to choose between several modes of operation such as 24-bits-per-pixel color, 8-bits-per-pixel color, 8-bits-per-pixel gray scale, 4-bits-per-pixel gray scale, or 1-bit-per-pixel line drawing mode. Typically, the mode of operation is selected prior to the actual image capture. However, some devices, such as digital cameras, may capture data only in one mode, such as 24-bits-per-pixel color, and then require later conversion to a different mode, if desired.

[0004] Some image sources may contain a mixture of color data, gray scale data, and line drawing or text data. In this case, typically the entire image will be captured in color, even though other portions of the image may contain no color information. Processing of the image could be sped up if the gray scale portion could be recognized and stored as gray scale data instead of full color data. Processing of the image could be further accelerated if the text or line drawing portions could be recognized and stored as 1-bit-per-pixel binary data instead of full color or gray scale data.

[0005] There is a need in the art for image capture devices that automatically detect the differences between color, gray scale, and text or line drawing images. Further, there is a need in the art for image capture devices that automatically switch between color, gray scale, and text or line drawing capture modes on the fly during the image capture process. This could relieve the user from the chore of deciding which capture mode to use and would allow a combination of modes within a single image without input from the user.

SUMMARY OF THE INVENTION

[0006] Within an image capture device, such as a scanner, a circuit is included that monitors the color content of the image as it is captured. This adaptive mode-switching method allows the device to automatically switch between full color, gray scale, and possibly line drawing modes. When the color content drops below a programmable threshold, the device automatically switches to gray scale mode. The color content is further monitored and if the color content rises above the programmable threshold, the device automatically switches back to color mode. Further, if a portion of the image contains only text or black and white line drawings, the device automatically switches to a 1-bit-per-pixel line drawing mode.

[0007] The color content may be determined in a number of ways. One embodiment of this invention converts the incoming color data to a color space including saturation and intensity contents. The saturation content of the incoming color data is accumulated for a block of data and compared against a programmable threshold. If the saturation is greater than the programmable threshold, the device passes the full color data to the downstream image processing pipeline along with a control signal specifying the data as full color data. If the saturation is less than the programmable threshold, the device passes the intensity content of the incoming color data to the downstream image-processing pipeline along with a control signal specifying the data as gray scale. This is possible since the intensity content of the incoming color image data is the gray scale content of the input data.

[0008] Another embodiment of this invention generates a saturation-per-pixel value averaged over a programmable number of pixels. The input data is converted to a color space including saturation and intensity data (assuming the input data is not already in such a color space), and the saturation content of the incoming color image data is accumulated. As each pixel of data is accumulated a pixel counter is incremented. The content of the saturation accumulator is divided by the content of the pixel counter to produce a saturation-per-pixel value. This saturation-per-pixel is compared to a programmable threshold. If the saturation-per-pixel value is greater than the programmable threshold, the full color image data is passed to the downstream image-processing pipeline along with a color mode signal specifying the data as color image data. If the saturation-per-pixel value is less than the programmable threshold, the intensity content of the incoming color image data is passed to the downstream image processing pipeline along with a color mode signal specifying the data as gray scale data. This is possible since the intensity content of the incoming color image data is the gray scale

content of the input data.

[0009] Yet another embodiment of this invention maintains a histogram of intensity data, and when the histogram shows a bimodal distribution, automatically switches the device into a 1-bit-per-pixel line drawing mode. This functionality may be combined with either of the embodiments described above, or may be used alone. For example, a black and white only device may simply need to switch between gray scale and 1-bit-per-pixel line drawing modes.

[0010] Other aspects and advantages of the present invention will become apparent from the following detailed description, taken in conjunction with the accompanying drawings, illustrating by way of example the principles of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] FIG. 1 is graphical representation of the hue, saturation, intensity (HSI) color space.

[0012] FIG. 2 is a block diagram of a representative embodiment of an adaptive mode-switching method.

[0013] FIG. 3 is a block diagram of another representative embodiment of an adaptive mode-switching method.

[0014] FIG. 4 is a block diagram of yet another representative embodiment of an adaptive mode-switching method.

[0015] FIG. 5 is a flowchart of a representative embodiment of an adaptive mode-switching method.

[0016] FIG. 6 is a flowchart of another representative embodiment of an adaptive mode-switching method.

[0017] FIG. 7 is a flowchart of yet another representative embodiment of an adaptive mode-switching method.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0018] FIG. 1 is a graphical representation of the hue, saturation, intensity (HSI) color space. Hue describes the most basic attribute of color, for example, pure red, pure green, or pure blue. Saturation is description of the portion of pure chromatic color in the total color. Saturation may be described as how deep (highly saturated) or how faded (lightly saturated) a color is. Intensity is a color-neutral attribute that describes the relative brightness of the color.

[0019] Hue, saturation, intensity color space is commonly represented by a double hexcone model such as that shown in FIG. 1. The surface of this double hexcone model represents maximum saturation (S=1). This model uses a polar coordinate system. In the example shown in FIG. 1, the vertical axis represents intensity, the hue is represented by the angle about the intensity axis, and the saturation is represented by the distance from the intensity axis. The intensity axis 122 of the model is shown in this example as the vertical axis, where

minimum intensity (I=0) is at the axis origin 102 of the model and maximum intensity (I=1) is at the point 104 of the model where the surface of the hexcone intersects the intensity axis 122 furthest from the origin and the intensity is defined to be 1. Minimum saturation (S=0) is represented by all points on the intensity axis 122 of the model. Saturation is represented by the distance 120 from the vertical (intensity) axis 122 to the point being considered.

[0020] Pure black is represented at the origin 102 of the model where intensity is equal to 0. Pure white is represented at point 104 of the model where intensity is equal to 1. At these two points, the saturation and hue are meaningless since the surface of the double hexcone meets the vertical axis at these points. In this model all the points where saturation is equal to 0 represent a gray scale color space. These points form the vertical line representing the intensity axis.

[0021] Hue is represented on this model by the angle 118 about the intensity axis 122. An angle of 0° about the vertical axis represents the color red. Pure red is represented by point 106 where the hue is 0°, the saturation is 1, and the intensity is 0.5. Pure yellow is represented by point 108 where the hue is 60°, the saturation is 1, and the intensity is 0.5. Pure green is represented by point 110 where the hue is 120°, the saturation is 1, and the intensity is 0.5. Pure cyan is represented by point 112 where the hue is 180°, the saturation is 1, and the intensity is 0.5. Pure blue is represented by point 114 where the hue is 240°, the saturation is 1, and the intensity is 0.5. Pure magenta is represented by point 116 where the hue is 300°, the saturation is 1, and the intensity is 0.5.

[0022] FIG. 2 is block diagram of a representative embodiment of an adaptive mode-switching method. Color image data 200 enters the system at the input to the saturation and intensity extraction block 202. The color image data may consist of RGB (Red/Green/Blue) data or other possible color models such as CMY (Cyan/Magenta/Yellow), HLS (Hue/Lightness/Saturation), HSI (Hue/Saturation/Intensity), or YIQ (intensitY/In-phase/ Quadrature) as used in the National Television System Committee (NTSC) system. If the incoming color image data is in a format where the saturation and intensity data already exist as separate sub-groups, the extraction block 202 simply splits apart the saturation and intensity data. Otherwise, the saturation and intensity extraction block 202 converts the color image data to a color space containing saturation and intensity data, such as the HSI (Hue/Saturation/Intensity) color space, using methods well known in the industry. (See, for example, a RGB to HSI converter in Fig. 13.33 from Foley, James D., et. al., *Computer Graphics: Principles and Practice,* 2nd ed., 1996, Addison-Wesley Publishing Company, Inc.) The saturation 204 output of the extraction block 202 is sent to the input of an accumulator 208. The intensity 206 portion of the color image data is sent to a multiplexor 220 that will be discussed below. The

accumulator 208 also has a clear input 210 to reset the accumulator 208 at the start of each group of color image data 200. The accumulator 208 sums the color content 212 of the current group of color image data 200. This color content 212 is compared against a programmable threshold 216 by a comparator 214. The output of the comparator 214 is the color mode 218, and it drives the select input of the multiplexor 220. When the current group of image data 200 contains substantially color image data, the color content 212 is greater than the programmable threshold 216, and the multiplexor 220 is controlled such that the output 222 of multiplexor 220 is the color data 200. This color data is then sent to the image processing pipeline 224. In the case where the current group of image data 200 contains substantially gray scale image data, the color content 212 is below the programmable threshold 216, so the multiplexor 220 is controlled such that the output 222 of multiplexor 220 is the intensity data 206. This intensity data is then sent to the image processing pipeline 224. Since the current group of data consists of gray scale data, the intensity portion of the data is all that is needed to properly display the data. The color mode 218 is also sent to the image-processing pipeline 224 so it will know whether to expect color data or gray scale data.

[0023] Note that this embodiment of the invention may be constructed in hardware, firmware, or as software in any given device.

[0024] FIG. 3 is a block diagram of another representative embodiment of an adaptive mode-switching method. Color image data 200 enters the system at the input to the saturation and intensity extraction block 202. The color image data may consist of RGB (Red/Green/Blue) data or other possible color models, such as CMY (Cyan/Magenta/Yellow), HLS (Hue/Lightness/Saturation), HSI (Hue/Saturation/Intensity), or YIQ (intensitY/In-phase/Quadrature) as used in the National Television System Committee (NTSC) system. If the incoming color image data is in a format where the saturation and intensity data already exist as separate sub-groups, the extraction block 202 simply splits apart the saturation and intensity data. Otherwise, the saturation and intensity extraction block 202 converts the color image data to a color space containing saturation and intensity data, such as the HSI (Hue/Saturation/Intensity) color space, using methods well known in the industry. (See, for example, an RGB to HSI converter in Fig. 13.33 from Foley, James D., et. al., *Computer Graphics: Principles and Practice*, 2nd ed., 1996, Addison-Wesley Publishing Company, Inc.) The saturation 204 output of the extraction block 202 is sent to the input of a saturation calculator 300. The intensity 206 portion of the incoming color image data is sent to a multiplexor 220 that will be discussed below. The saturation calculator 300 also has a clear input 210 to reset the saturation accumulator 306 and the pixel counter 304 at the start of each group of color image data 200. A new pixel 302 input to the saturation calculator 300 increments the pixel counter 304

as the saturation data for each pixel is added in the saturation accumulator 306. The accumulated saturation data is divided by the number of pixels in a divider 308 to produce a saturation-per-pixel output 310. The saturation-per-pixel output 310 of the saturation calculator 300 is the saturation content of the current group of color image data 200. This saturation-per-pixel output 310 is compared against a programmable threshold 216 by a comparator 312. The output of the comparator 312 is the color mode 218, and it drives the select input of the multiplexor 220. When the current group of image data 200 contains substantially color image data, the saturation-per-pixel output 310 is greater than the programmable threshold 216, so the multiplexor 220 is controlled such that the output 222 of the multiplexor 220 is the color image data 200. This color image data is then sent to the image processing pipeline 224. In the case where the current group of image data 200 contains substantially gray scale image data, the saturation-per-pixel output 310 is below the programmable threshold 216, so the multiplexor 220 is controlled such that the output 222 of the multiplexor 220 is the intensity data 206. This intensity data is then sent to the image processing pipeline 224. Since the current group of data consists of gray scale data, the intensity portion of the data is all that is needed to properly display the data. The color mode 218 is also sent to the image-processing pipeline 224 so it will know whether to expect color data or gray scale data.

[0025] Note that this embodiment of the invention may be constructed in hardware, firmware, or as software in any given device.

[0026] FIG. 4 is a block diagram of yet another representative embodiment of an adaptive mode-switching method. In this embodiment, the mode-switching circuitry is designed to detect portions of an image containing line drawings or text. The incoming image data 200 may be either color or gray scale image data. This image data 200 is received by a histogram block 400, a threshold block 408, and a multiplexor 220. Each of these blocks will be described in detail. The histogram block 400, maintains a histogram of the intensity portion of the incoming image data 200. In cases of image data containing text or line drawings the resulting histogram will show a bimodal distribution. The histogram analysis block 404 performs this analysis of the histogram it receives from the histogram block 400. If a bimodal distribution is detected, the histogram analysis block 404 determines the intensity at the minimum between the two lobes of the bimodal distribution. This intensity is the threshold 406 below which a pixel is considered black and above which a pixel is considered white. The threshold 406 is sent to the threshold block 408 where the intensity portion of the incoming image data 200 is compared to the threshold 406. If the intensity of the incoming image data 200 is below the threshold 406 a binary data bit 410 representing a black pixel is output. If the intensity of the incoming image data 200 is above the

threshold 406 a binary data bit 410 representing a white pixel is output. This binary data 410 is an input to the multiplexor 220 in addition to the incoming image data 200. The histogram analysis block 404 also outputs a mode control signal 412 that is used to control the multiplexor 220 and is also sent to the downstream image processing pipeline 224. The mode control signal 412 drives the select line of the multiplexor 220 to determine whether the full image data 200 is to be passed through the multiplexor 220 to its output 222, or if the binary data 410 is to be passed through to the multiplexor output 222. The output 222 of the multiplexor 220 is then sent to the downstream image processing pipeline 224.

[0027] Note that this embodiment of the invention may be constructed in hardware, firmware, or as software in any given device.

[0028] FIG. 5 is a flowchart of a representative embodiment of an adaptive mode-switching method. The method starts in a step 500. In a step 502 an accumulator is cleared to begin receiving data from a new group of pixels. In this embodiment, a group of pixels may consist of, for example, a set number of pixels, a single image raster line, a segment of a single image raster line, or a rectangular block of pixels. Other sizes and shapes of groups of pixels may be implemented within the scope of this invention. In a step 504, the saturation and intensity portions of the incoming color image data are extracted for a pixel. In a step 506, the saturation portion of the incoming color image data is added to the contents of the accumulator. After the accumulation is performed, a decision step 508 is reached. In a decision step 508, if the accumulated saturation data is greater than a threshold, the device is switched to full color mode in a step 510. If the device is already in full color mode, step 510 leaves the device in full color mode. If the accumulated saturation data is not greater than a threshold, the device is switched to grayscale mode in a step 512. If the device is already in grayscale mode, step 512 leaves the device in gray scale mode. After the mode is switched, a decision step 514 is reached. In a decision step 514, if there are more pixels to process in a group, the method returns to step 504. In a decision step 516, if there are more groups of pixels in the image, control is returned to step 502 for a new group of pixels. If the image is completed, the method ends in a step 518.

[0029] FIG. 6 is a flowchart of another representative embodiment of an adaptive mode-switching method. The method starts in a step 600. In a step 602, a pixel counter and accumulator are cleared to begin receiving data from a new group of pixels. In this embodiment, a group of pixels may consist of, for example, a set number of pixels, a single image raster line, a segment of a single image raster line, or a rectangular block of pixels. Other sizes and shapes of groups of pixels may be implemented within the scope of this invention. In a step 604, the saturation and intensity portions of the incoming color image data for a pixel are extracted. In a

step 606, the pixel counter is incremented. In a step 608, the saturation portion of the incoming color image data is added to the contents of the accumulator. In a step 610, the contents of the accumulator are divided by the contents of the pixel counter to generate a saturation-per-pixel number. In a decision step 612, if the saturation-per-pixel is greater than a threshold, the device is switched to full color mode in a step 614. If the device is already in full color mode, step 614 leaves the device in full color mode. If the saturation-per-pixel is not greater than a threshold, the device is switched to grayscale mode in a step 616. If the device is already in grayscale mode, step 616 leaves the device in grayscale mode. In a decision step 618, if there are more pixels to process in the current group of pixels, control returns to step 604 for the next pixel. If there are no more pixels to process in the current group, a decision step 620 is reached. In a decision step 620, if there are more groups of pixels in the image, control is returned to step 602 for the next group of pixels. If there are no more groups of pixels in the image, the image is completed, and the method ends in a step 622.

[0030] FIG. 7 is a flowchart of yet another representative embodiment of an adaptive mode-switching method. The method starts in a step 700. In a step 702, the histogram is cleared to begin receiving data from a new group of pixels. In this embodiment, a group of pixels may consist of, for example, a set number of pixels, a single image raster line, a segment of a single image raster line, or a rectangular block of pixels. Other sizes and shapes of groups of pixels may be implemented within the scope of this invention. In a step 704, the intensity portion of the incoming image data for a pixel is extracted. In a step 706, the intensity data is added to the histogram. After the histogram is updated, a decision step 708 is reached. In a decision step 708, if the histogram does not show bimodal distribution the device is switched to full color or grayscale mode in a step 710. If the device is already in full color or grayscale mode, step 710 leaves the device in this mode. If the histogram shows bimodal distribution, a binary threshold is set in a step 712, and the device is switched into line drawing (1-bit-per-pixel) mode in a step 714. If the device is already in line drawing (1-bit-per-pixel) mode, step 714 leaves the device in this mode. In a decision step 716, if there are more pixels to process in the current group, control is returned to step 704. If there are no more pixels to process in the current group a decision step 718 is reached. In a decision step 718, if there are more groups of pixels to process in the image, control is returned to step 702 to start processing the next group of pixels. If the image has been completed, the method ends in a step 720.

[0031] The foregoing description of the present invention has been presented for purposes of illustration and description. It is not intended to be exhaustive or to limit the invention to the precise form disclosed, and other modifications and variations may be possible in light of

the above teachings. The embodiments were chosen and described in order to best explain the principles of the invention and its practical application to thereby enable others skilled in the art to best utilize the invention in various embodiments and various modifications as are suited to the particular use contemplated. It is intended that the appended claims be construed to include other alternative embodiments of the invention except insofar as limited by the prior art.

Claims

1. A circuit comprising:

   an accumulator 208 that accumulates a saturation portion 204 of incoming color image data 200; and
   a multiplexor 220 that receives said color image data 200 and outputs said color image data 200 when said accumulator output 212 is greater than a programmable threshold 216, and outputs an intensity portion 206 of said color image data 200 when said accumulator output is less than said programmable threshold 216.

2. A circuit comprising:

   a saturation calculator 300 that calculates saturation-per-pixel from a saturation portion 204 of incoming color image data 200; and
   a multiplexor 220 that receives said color image data 200 and outputs said color image data 200 when said saturation-per-pixel 310 is greater than a programmable threshold 216, and outputs an intensity portion 206 of said color image data 200 when said saturation-per-pixel 310 is less than said programmable threshold 216.

3. A circuit comprising:

   an accumulator 208 that accumulates a saturation portion 204 of incoming color image data 200; and
   a multiplexor 220 that receives said color image data 200 and outputs either said color image data 200 or an intensity portion 206 of said color image data 200; wherein said color image data 200 is output when said accumulator output 212 is greater than a programmable threshold 216, and said intensity portion 206 of said color image data 200 is output when said accumulator output 212 is less than said programmable threshold 216.

4. A circuit comprising:

   a saturation calculator 300 that calculates sat-

uration-per-pixel 310 from a saturation portion 204 of incoming color image data 200; and
a multiplexor 220 that receives said color image data 200 and outputs said color image data 200 when said saturation-per-pixel 310 is greater than a programmable threshold 216, and outputs an intensity portion 206 of said color image data 200 when said saturation-per-pixel 310 is less than said programmable threshold 216.

5. A circuit comprising:

   a histogram block 400 that receives incoming image data 200 and creates a histogram 402 of the intensity portion of the image data;
   a histogram analysis block 404 that receives histogram data from said histogram block 400, calculates an intensity threshold 406 from said histogram data 402, and asserts a mode control signal 412 if said histogram data 402 has a bimodal distribution;
   a threshold block 408 that receives said incoming image data 200 and said intensity threshold 406, and converts said incoming image data 200 to a 1-bit-per-pixel format using said intensity threshold 406; and
   a multiplexor 220 that receives said incoming image data 200 and said 1-bit-per-pixel data 410, outputs said 1-bit-per-pixel data 410 when said mode control signal 412 is asserted, and outputs said incoming image data 200 when said mode control signal 412 is not asserted.

6. A method for scanning images comprising the steps of:

   accumulating 506 a saturation portion 204 of incoming color image data 200;
   outputting said color image data 200 when said accumulated saturation data 212 is greater than a programmable threshold 216; and
   outputting an intensity portion 206 of said color image data 200 when said accumulated saturation data 212 is less than said programmable threshold 216.

7. A method for scanning images comprising the steps of:

   calculating 610 a saturation-per-pixel value 310 from a saturation portion 204 of incoming color image data 200;
   outputting said color image data 200 when said saturation-per-pixel value 310 is greater than a programmable threshold 216; and
   outputting an intensity portion 206 of said color image data 200 when said saturation-per-pixel value 310 is less than said programmable

threshold **216**.

8. A method for scanning images comprising the steps
    of:

      accumulating **608** a saturation portion **204** of
      incoming color image data **200**;
      outputting said color image data **200** when said
      accumulated saturation data **212** is greater
      than a programmable threshold **216**; and
      outputting an intensity portion **206** of said color
      image data **200** when said accumulated satu-
      ration data **212** is less than said programmable
      threshold **216**.

9. A method for scanning images comprising the steps
    of:

      calculating a saturation-per-pixel value **310**
      from a saturation portion **204** of incoming color
      image data **200**;
      outputting said color image data **200** when said
      saturation-per-pixel value **310** is greater than a
      programmable threshold **216**; and
      outputting an intensity portion **206** of said color
      image data **200** when said saturation-per-pixel
      value **310** is less than said programmable
      threshold **216**.

10. A method for scanning images comprising the steps
    of:

      Creating **706** a histogram of the intensity por-
      tion of incoming image data **200**; asserting a
      mode control signal **412** if said histogram data
      402 has a bimodal distribution;
      calculating **712** an intensity threshold **406** from
      said histogram data **402**; converting said in-
      coming image data to a 1-bit-per-pixel format
      using said intensity threshold **406**;
      outputting said incoming image data **200** when
      said mode control signal **412** is not asserted;
      and
      outputting said 1-bit-per-pixel image data **410**
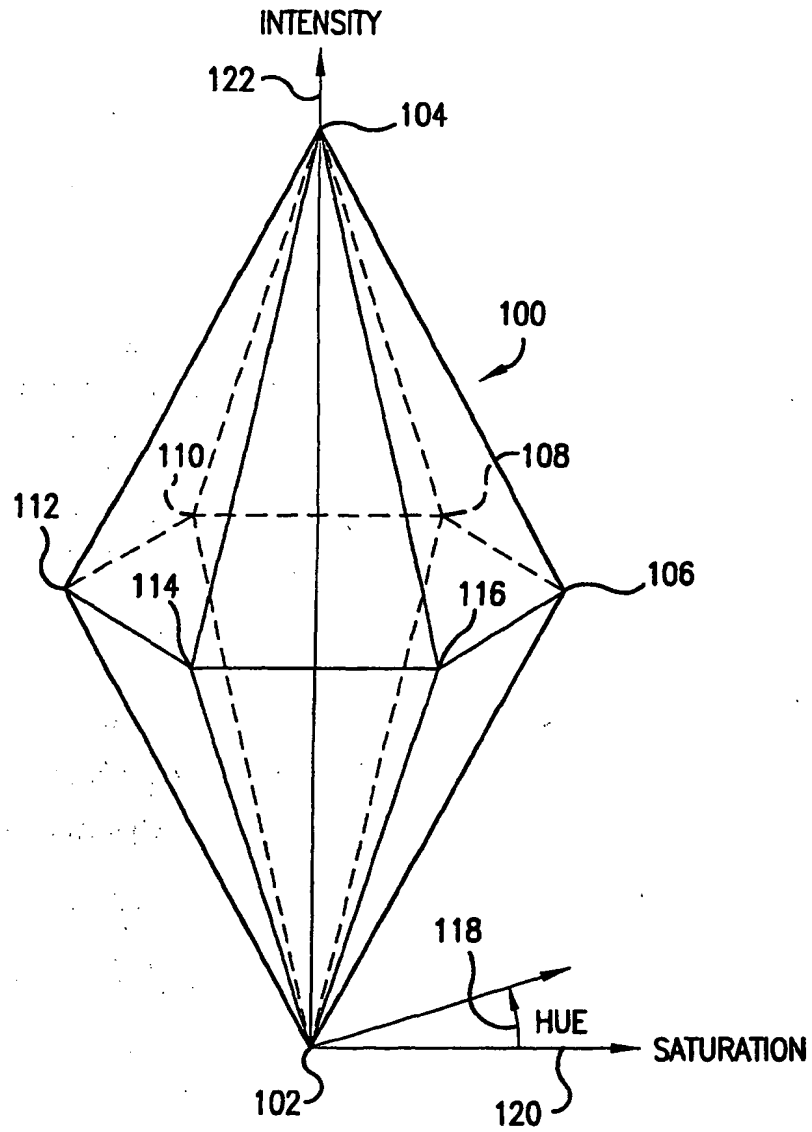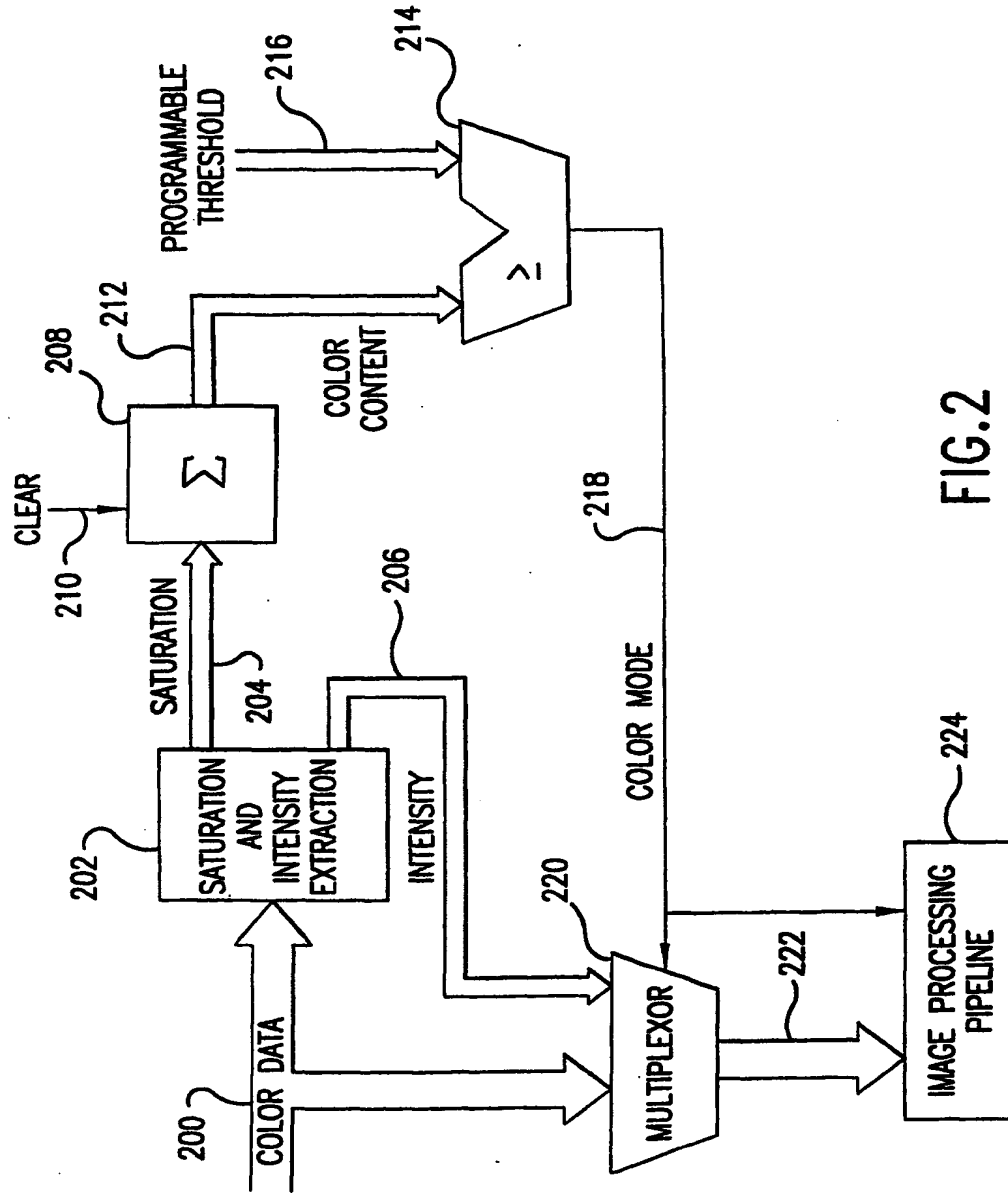   when said mode control signal **412** is asserted.
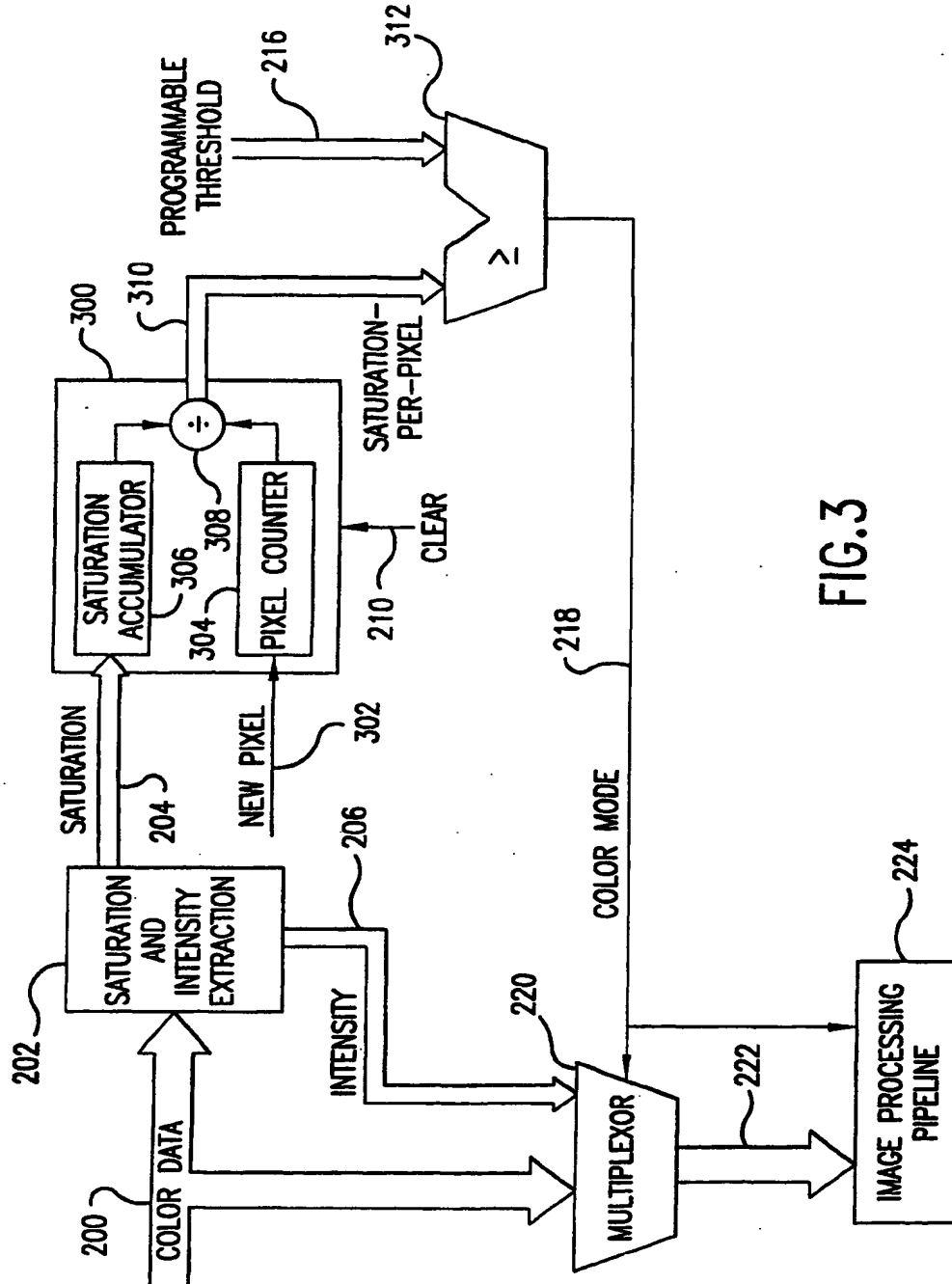
INTENSITY

122 104

100

110 108

112

114 116 106

118

HUE

102 SATURATION

120

FIG.1

FIG.2

FIG.3

FIG.4

START ~ 500

CLEAR ACCUMULATOR ~ 502

EXTRACT SATURATION AND INTENSITY PORTIONS OF INCOMING COLOR IMAGE DATA FOR A PIXEL ~ 504

ADD SATURATION PORTION OF PIXEL DATA TO ACCUMULATOR ~ 506

508 ~ IS ACCUMULATED SATURATION DATA>THRESHOLD ? — NO

YES

510 ~ SWITCH TO FULL COLOR MODE

512 ~ SWITCH TO GRAYSCALE MODE

514 ~ END OF GROUP OF PIXELS ? — NO

YES

516 ~ MORE GROUPS OF PIXELS ? — NO — END ~ 518

YES

FIG.5

12

START ⟶ 600

CLEAR PIXEL COUNTER AND ACCUMULATOR ⟶ 602

EXTRACT SATURATION AND INTENSITY PORTIONS OF INCOMING COLOR IMAGE DATA FOR A PIXEL ⟶ 604

606 ⟶ INCREMENT PIXEL COUNTER

ADD SATURATION PORTION OF PIXEL DATA TO ACCUMULATOR

608 ⟶

DIVIDE ACCUMULATED SATURATION DATA BY PIXEL COUNT

610 ⟶

612 ⟶ IS SATURATION-PER-PIXEL>THRESHOLD ? — NO

YES

SWITCH TO FULL COLOR MODE

616 ⟶ SWITCH TO GRAYSCALE MODE

614 ⟶

END OF GROUP OF PIXELS ? — NO
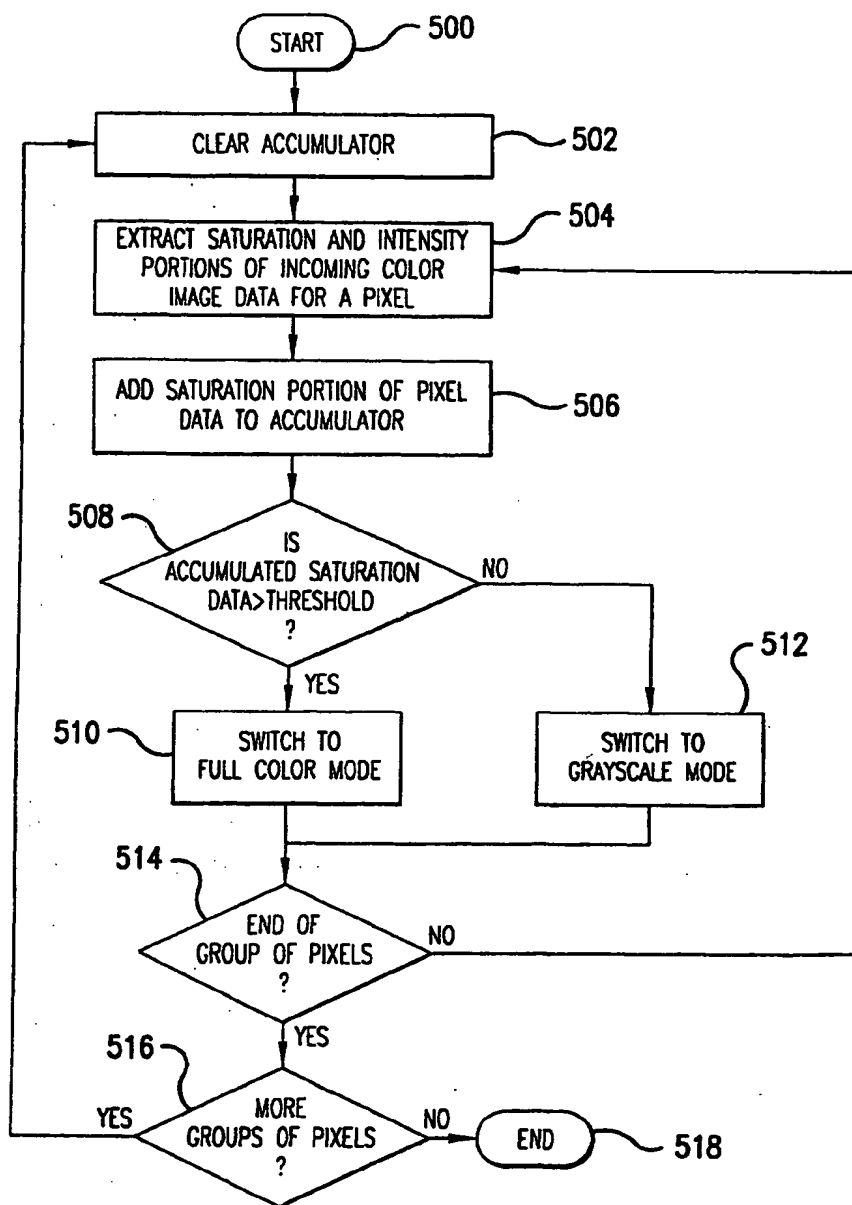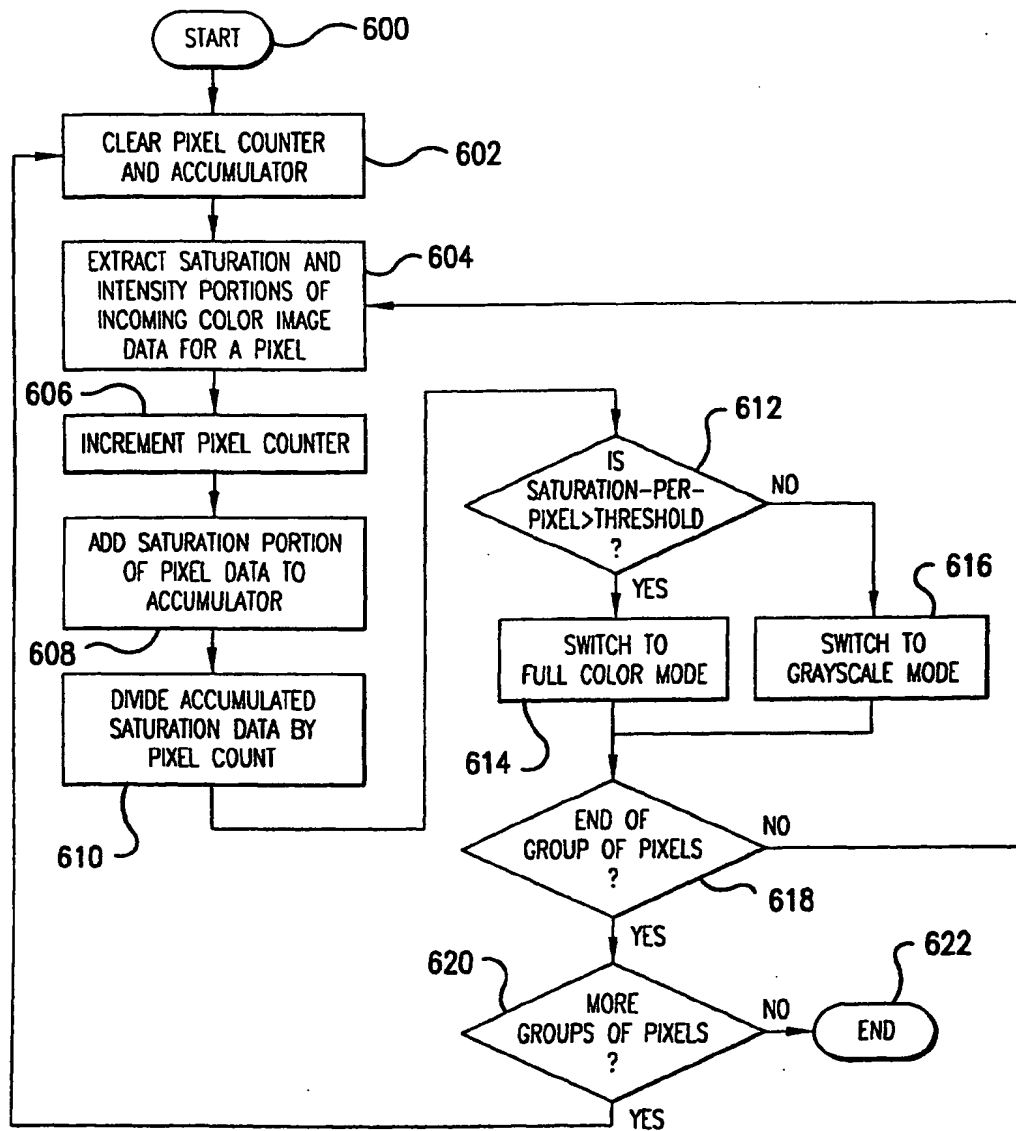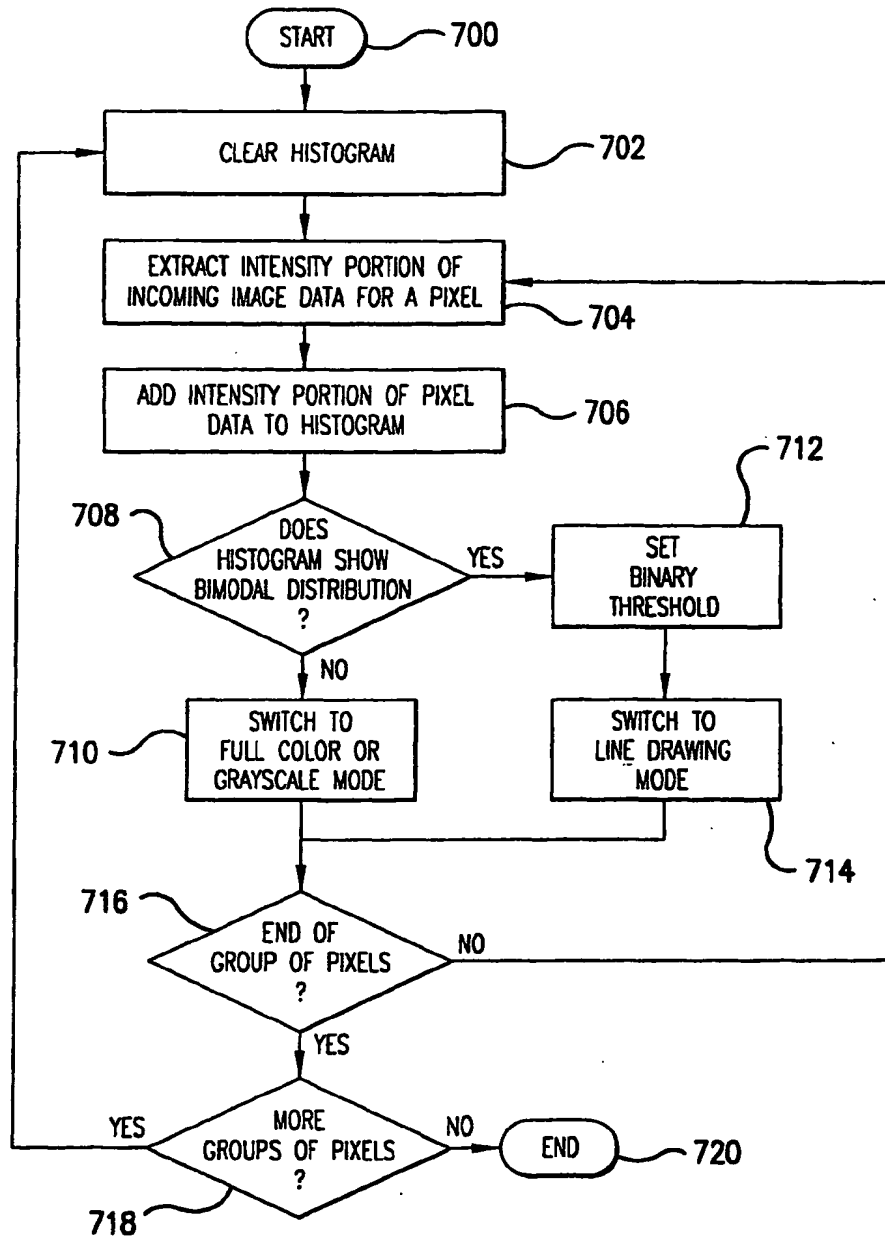
618

YES

620 ⟶ MORE GROUPS OF PIXELS ? — NO ⟶ END ⟶ 622

YES

FIG.6

FIG.7

European Patent
Office

EUROPEAN SEARCH REPORT

Application Number

EP 01 30 3592

	DOCUMENTS CONSIDERED TO BE RELEVANT		
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
X	EP 0 448 330 A (CANON KK) 25 September 1991 (1991-09-25) * page 6, line 5 - page 7, line 11 * * page 8, line 1 - line 57 * * page 18, line 9 - line 13 * * page 18, line 20 - line 29 * ---	1-4,6-9	H04N1/56
X	EP 0 195 925 A (IBM) 1 October 1986 (1986-10-01) * abstract; figures 1,9 * ---	5,10	
A	US 5 796 928 A (ABE TOSHIHUMI ET AL) 18 August 1998 (1998-08-18) * abstract; figure 5 * * column 7, line 18 - line 24 * * column 8, line 35 - line 47 * * column 9, line 1 - column 10, line 12 * ---	1-10	
A	US 5 724 440 A (ARIMOTO SHINOBU ET AL) 3 March 1998 (1998-03-03) ---		TECHNICAL FIELDS SEARCHED (Int.Cl.7)
A	US 5 721 628 A (FUNADA MASAHIRO ET AL) 24 February 1998 (1998-02-24) -----		H04N

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
BERLIN	7 August 2001	Kassow, H

15

ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.   EP 01 30 3592

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